Project START!

Enabling hundreds to enable thousands

Sample Module Overviews

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Module #1: Egg Drop

General Description

The Egg Drop is a competitive game in which the goal is to design and build a system that will protect an egg from a 1 meter (3.3 feet) drop. Eggs that smash or crack fail the test while eggs that survive without a scratch pass!

Presentation

The student volunteers will moderate small group discussions as to how best to protect the egg. *How can you protect a falling egg?* The main aim of an egg drop experiment is to develop the scientific approach while exploring the physics used in car air bags, helmets, and more everyday items.

Major Concepts

There are three ways to protect your egg: (1) Lower the energy at impact (ex. parachute, starting at lower height) (2) Increasing the time over which the impact occurs (ex. helmet) (3) Increase the distance over which the impact occurs (ex. airbag).

Interactive Activity

The children will build their egg protection. Then the competition begins. The rules are simple: *Double wrap your egg, Watch the clock, One chance, Three falls.*
The module will end with an interactive Q and A review of all of the concepts involved.

Materials

Eggs, Paper towels, Plastic straws, Popsicle sticks, Tape, Cups, Rubber Bands, Bubble Wrap, Recycled paper, Glue, Plastic bags (parachutes), Ziploc Bags (for double bagging the eggs before building their protective cages), Boxes, Plastic containers.

Module #2: Forensic Chemistry

General Description

Science plays an integral role in detective work. In this module, we challenge the children to discover the ways that chemistry is important in forensics work. A "crime scene" is set up with an actual letter found and fingerprints (of one of the START! leaders) discovered on markers found at the crime scene. Over the course of the lesson, START! leaders work with the children to analyze the evidence using scientific principles in order to solve the mystery.

Activities

1. *Fingerprinting Experiment*
   Presentation:
   Explain that there are two types of fingerprints--visible and latent. Explain why children's latent prints do not last as long on surfaces as adults' prints do. Explain how to collect both types of fingerprints (visible and latent; see below), and the mechanism by which superglue can make fingerprints "develop."

   Activity:
   Observe visible fingerprints using ink pads.Use an ink pad to make a fingerprint on a piece of paper. The type of print (loops, whorls, arches) tends to run in the family, but the exact pattern is unique to each individual.) Compare by using a magnifying glass to inspect your fingers.

   Observe latent fingerprints: Hold a microscope slide for a few seconds so that your fingers leave latent prints. Label the slide and place it under a jar. Put several drops of superglue on the middle of a square of aluminum foil folded in fourths, and then turn the glass jar upside down over the glue on the foil. The cyanoacrylate fumes in the glue will react with the residue from your fingers. You should see white fingerprint images on the object after a half hour. Note that the superglue makes the fingerprints "permanent."

   To relate children's observations to our "crime scene," we compare the fingerprints on the worksheet to yours and to those of the START! leaders. Did any of them commit the crime?

2. *Chromatography Experiment*
   Presentation:
   Explain chromatographic methods, how polarity plays a role, and how chromatography would help to solve a crime. Worksheet is provided for reinforcement.

Activity:
Use chromatography to analyze different pen and ink colors to help determine which brand of pen a suspect used on paper. Each student analyzes each of the four pens found at the crime scene by chromatography. Place a small dot on a piece of filter paper, placing the paper's edge in a container of alcohol, then wait until the liquid is absorbed and observe the differences.

We have a letter from our "crime scene," which was analyzed by chromatography. Is the letter written by one of the markers? Is it written by one of the pens?

Materials

Fingerprinting:
(8 magnifying glasses,) jars/cups, inkpads, papers, 1 box of microscope slides, squares of aluminum foil, superglue.

Chromatography:
Worksheet (self prepared), markers, pens, filter paper slips, alcohol, cups.

Resources

Fingerprinting
http://www.senseme.com/scripts/biometrics/fingerprints.htm
Chromatography
http://www.msichicago.org/fileadmin/Education/learninglabs/lab_downloads/EvidenceLab_ink_act.pdf

Module #3 – Foam Tube Rollercoasters

General Description

The concept of conversion of energy is sometimes difficult to understand. How can Potential Energy turn into Kinetic Energy? It is often easier to understand the concept when you're at the top of a rollercoaster and then moving quickly on its downward slope. It is easiest to understand when you build the rollercoaster yourself.

Activities

Presentation:
Demonstrate the conversion of (Electrical Energy to) Heat to Mechanical Energy with an electrically-powered steam engine.
Next, demonstrate the conversion of Mechanical Energy to Heat by rubbing your hands together.
Explain the concept of Potential Energy and how it can be converted to Kinetic Energy.

Project:
Make it happen! Build rollercoasters in teams of four out of the foam tubes. Use the tape and popsicle sticks to stabilize the rollercoasters. See if you can make a loop-the-loop. What kind of conversion of energy occurs at the top of the loop? (Kinetic Energy to Potential Energy)

Materials

Popsicle sticks, foam tubes, marbles, tape

Resources

http://www.sciencebuddies.org/science-fair-projects/project_ideas/Phys_p036.shtml#background

Module #4 – Building Bridges

General Description

Why are triangles used so often in bridges? (They don't "bend" easily.) How do engineers figure out how to make the strongest, most stable bridges? How do you make a bridge more efficient? (Make it stronger with less material.) Can you be the engineer?

Activities

Presentation:

Show Bus Clip [see link 2 below] and Magic School Bus Video 2 [3:58 – 4:18 and 4:50 – 5:20 and 8:00 – 9:40] and discuss shapes and sturdiness of various bridge types (Arch, Beam, Suspension, Cable-stayed). Images for the discussion can be found in link 3. Page four of the linked (link 4) document provides a worksheet for each of the students to reinforce the lesson. Finally, the bridge-building competition will be introduced.

Project:

The bridge-building competition will be introduced. Using the newly gained knowledge, teams of four children each will attempt to build the sturdiest bridge. The only materials provided to build the bridge are gumdrops and toothpicks. Specifications regarding the number of gumdrops and toothpicks will be imposed to keep things fair.

Bridge competition – Weights are hung from each of the bridges, and the team with the bridge that has the highest Strength/Mass ratio wins a prize. The strength of the bridge is determined by the amount of weight that it can hold before collapsing. The efficiency is determined by dividing the weight held by the amount of gumdrops used.

Materials

Computer-access with internet to show the clips, Worksheet from Page four of this document, The bridge materials. Testing bar. Weight holder and weights (from the physics lab), scale (to weigh the bridges). The Prizes.

Resources

http://www.scholastic.com/teachers/lesson-plan/magic-school-bus-under-construction
https://www.youtube.com/watch?v=eACmkG8lIWQ#t=9m29s
http://www.google.com/url?q=http%3A%2F%2Fwww.pbs.org%2Fwgbh%2Fnova%2Fbridge%2Fbuild.html&sa=D&sntz=1&usg=AFQjCNFfKiKuBvKnYdq-AByl_PyG_NkQEg
http://www.engineeringplanet.rutgers.edu/pdf/lessons/engineering/civil_enviromental/2004/lesson10.pdf

Module #5 – LED Lights

General Description

What powers our cell phones? Our computers? Our cars? How does electricity work? The best way to explore this topic of basic electronics concepts is to build circuits yourself. In this module, we experiment with resistors, LEDs, and wires. We explain how the motion of high energy electrons through these components is somewhat like cars on a highway, generating usable energy. We use circuit boards (one for every four students) to explore the basics of circuitry, including short circuits, and resistors in series and in parallel.

Activities

Presentation and Project:

1. We describe how electricity works: Currents carry high energy particles from high energy to low energy. To do this, a closed circuit is required.
   Build a simple circuit; make your LED glow!
2. Resistors decrease the current.
   Add a resistor; what happens to the light?
3. Short the circuit (show what this means)
   What happens to the light? Why? (The current has a path of less resistance.)
4. Resistors in parallel
   What happens to the light when you add a second resistor in parallel? Why is it brighter than with just one resistor? (It's comparable to two EZ pass lanes.)

Materials

Circuit Board, resistors, wires, LEDs.

Module #6 – DNA Extraction

General Description

What tells our bodies what to do? Who is sitting in the "driver's seat" of our body telling it what things to make? Why does our hand look different than our head when the cells are made of all the same things? Where is our DNA? Where does it come from? Did you know we are 50% identical to bananas?

DNA can be compared to a recipe off of which our bodies are built and maintained. For example, your grandmother makes the best chocolate chip cookies on the planet and you want to make a batch. First, you go to her house and make a copy of the recipe, only taking the copy with you so that the original would stay safe with Grandma (transcription -- make a copy of the DNA into RNA, but the DNA stays in the nucleus for safekeeping). Then back at home, you follow the copy that you made of the recipe to add the ingredients in the right order to successfully make the cookie (translation -- the RNA is used as a template to build proteins).

Activities

Presentation:

The presentation contains a discussion of where precisely DNA is found, and its biological role. There is also a discussion of our evolutionary relationships to other species that share DNA with us. See above.

Project:

The experiment involved rinsing your mouth with water, spitting it into a cup, adding salt and soap to isolate, and removing the DNA from the cells, and then adding alcohol to precipitate the DNA. We then used toothpicks to remove the DNA and put it into Eppendorf tubes for the students to keep.

Materials

1.5 mL Eppendorf tubes, String (for making into necklaces), Dish Soap, Alcohol, Toothpicks, Table salt, plastic cups, Water

Resources

http://www.youtube.com/watch?v=DaaRrR-ZHP4&feature=player_embedded

Module #7 – Neuroscience

General Description

What is the nervous system and how does it work? How does the brain send messages throughout the body? The START leaders discuss how the central nervous system and the peripheral nervous system are bridged together: Neurons. The children learn about the different parts of a neuron (dendrite, cell body, axon) and how they function in helping the neurons to communicate with one another.

Activities

Presentation

Discuss the different components of the nervous system. Explain that the brain is the command center of the body and that it transmits its messages via neurons. Use different analogies to explain what a neurotransmitter is and how it bridges together all the neurons and helps send messages throughout the body. The description of a relay race can be used to explain that each neuron is like a different participant in the race and in order for the next runner (or neuron) to start, the previous runner has to hand him the baton (neurotransmitter).

Activity

Using the knowledge from the presentation, children actively build giant models of neurons out of containers and ropes to illustrate the properties of chemical transmission and action potentials. The neuron is assembled through the use of ropes as dendrites and axons, containers as cell bodies and axon terminals and ping pong balls as neurotransmitters. Each individual neuron helps to elucidate the connection between neurons and neurotransmitters, while the group model which connects each neuron together will demonstrate the action potential and explain the reaction taking place.

The neuron competition and dance-off: One child is the "brain" of the neurons and commands that two other children have to do a dance move. Each child has a team of neurons and they can't do their dance move until each signal gets sent through all their neurons -- whichever team sends the action potential the quickest wins and their kid can do the dance move.

Materials

Plastic containers, Ping pong balls, Rope, Rolls of tape

Resources

http://brainu.org/files/movies/action_potential_cartoon.swf

Module #8 – Ice Cream Making

General Description

In this module the students learn about phase change in a fun and yummy way. They learn why we sprinkle rock salt on the ground after it snows. Salt lowers the freezing point of water from 32 degrees Fahrenheit to a lower temperature that is dependent on how much salt is used. Ordinarily when water freezes, the temperature is low enough to make the water molecules stop moving around and arrange themselves in a very orderly fashion. When salt is added to water the water becomes impure and the water molecules cannot form the crystalline structure as easily, so a lower temperature is needed to freeze the water. Milk freezes at a lower temperature than water, so we add enough ice to lower the freezing point of the water to be equal to or less than that of milk.

Activities

Presentation:
We discussed some fun facts about ice cream to get all the kids even more excited about the experiment. Then we explained the science behind what we're doing, in a very basic and simple way: we gave the example of how we put salt on the ground when it snows so that the snow can't freeze into ice because the salt particles get in the way of forming a more solid structure of water. Salt also makes the ice melt because it breaks up the bonds in the ice to make it change into the liquid form. We also mentioned terms like freezing point/melting point and how salt lowers that temperature.

Project:
Mix the milk, vanilla, and sugar together in one of the sandwich bags. Seal it tightly leaving as little air as possible. Place this bag in another sandwich bag (to prevent leaking). Place this inside the gallon bag and add ice and salt. Seal this bag with as little air as possible. Wrap bag in paper towels (to keep hands warm) and massage and shake the bag for 5-7 minutes. Take out the small bags, which now contain ice cream, scoop out into bowls, add toppings and enjoy!

Materials

Ziploc bags: sandwich size and gallon size; plastic cups (measuring cups); spoons and bowls; paper towels; rock salt; ice cubes; milk; sugar; vanilla extract; sprinkles and other toppings

Resources

http://chemistry.about.com/cs/howtos/a/aa020404a.htm

Module #9 – Earthworm Dissection

General Description

Earth is filled with millions of types of organisms, each with varying degrees of complexity. They vary from as small as single-cell bacteria to massive mammals like elephants and whales. Organisms are classified into different groups based on similarities to each other in a science known as taxonomy. While all organisms in a kingdom are similar to each other in some way, the organisms in one phylum are more similar than those in a different one. Classification gets narrower as we separate into class, order, family, genus, and species. Humans and earthworms are both in the animal kingdom, but humans are in the phylum Chordata while earthworms are in the phylum Annelida. Dissecting an earthworm allows us to see its organs and how dissimilar it is from humans.

Activities

Presentation:

Teach the students about the different organs in the worm. Discuss the anatomy, life-cycle of the worm, the five different hearts, how it produced nutrients that help plants grow.

Project:

Break up into groups and dissect the earthworms.

Materials

Dead earthworms; dissection kits; gloves

Resources

http://www.hometrainingtools.com/worm-dissection-project/a/1319/

Module #10 – Balloon Lung Models

General Description

Ever wonder why you breathe and how it works? Like other mammals, humans rely on a large amount of energy made available through the metabolism of food and oxygen. Humans and many other organisms are called "aerobic" organisms because they need oxygen in order to survive. In this model, students learn the concept of respiration and how the lungs and the diaphragm function to draw in and expel air.

Activities

Presentation:
We started off with a discussion of what we breathe (oxygen, carbon dioxide), how much we breathe (depends on multiple factors including physical activity), and then how we breathe. We talked about the way the diaphragm controls the size of lungs and inhalation and exhalation.

Project:
We then constructed model lungs out of plastic bottles with the bottoms cut out, and a balloon stretched over the bottom to represent the diaphragm and a second balloon inserted into the neck of the bottle to represent the lung. As students pulled down on the diaphragm, the lung filled with air. After the students understood the model intuitively, we discussed some things that can go wrong with respiration: choking, asthma, and a collapsed lung. For choking, we covered the top balloon, to show that even as the diaphragm pulled down, the lung would not fill up. For asthma, we taught about the bronchi within the lungs, then wrapped a twist tie around the balloon to show how asthma restricts airflow in the lung. To demonstrate a collapsed lung, we cut a hole in the top balloon with a scissor, and discussed how the presence of air in the thoracic cavity inhibits proper lung function.

Materials

Thick plastic bottles with bottoms cut off (use a hacksaw); Balloons; Scissors; Twist Ties;

Resources

http://kidshealth.org/teen/your_body/body_basics/lungs.html#a_Lungs__amp__Respiratory_System_Basics

Module #11 – Heart Rate

General Description

What is the heart? What keeps our bodies going? Why does the heart sometimes go faster? Why does it sometimes go slower? How can we measure how the heart is doing? What kinds of activities make our heart go faster and what kinds of activities make it go slower?

This module can also be used to teach scientific method. Together, we can invent hypotheses (what happens when we exercise or rest) and then test them, gathering data in the process!

Activities

Presentation:

The presentation discusses basic cardiac physiology and the role of the heart. The heart is emphasized as the organ that maintains perfusion of the body and as a muscle which requires development/exercise to stay strong. Aside from the discussion of cardiac physiology, there is also a discussion of scientific method.

Project:

Have students develop a hypothesis about what will happen when heart rate is increased, have them exercise, collect data, and test the hypothesis. Remember to test heart rate before exercise also to have a control in the experiment. Activities to increase heart rate can range from pushups to jumping-jacks to a relay race.

Materials

Stethoscopes, Timers or Clock

Module #12 – Electricity

General Description

What is physics? What is electricity? Where is it found? What does it do? What are the basic units of electricity (the electron)? What is current? Why do opposites attract and similar charges repel? What is a circuit? How can we be safe around electricity?

This module has two basic parts:

Part 1: Static Electricity
Opposite charges attract while like charges repel. Three experiments are then performed using balloons to illustrate. For all of the experiments, students charge balloons by rubbing them on their clothes. For the first experiment, students place the charged balloons near their hair and watching as their hair stands up. For the second experiment, students bring two charged balloons next to each other and watch as they repel. For the third experiment, students move soda cans without touching them by using charged balloons.

Part 2: Dynamic Electricity
We explained to the students that circuits can only function if there is a complete path upon which the electrons can travel. We then showed them how to make different types of circuits on a circuit board to light up a light bulb, (plain circuit, series vs parallel, using a resistor, using a switch). We also told them about the dangers of short circuits and of touching live wires.

Activities

Presentation:
The presentation discusses the nature of physics, electrons, and electricity in particular. Each of the concepts discussed above is outlined and explained in preparation for the experimental portion of the presentation.

Project:
Students use balloons to test hypotheses about the fundamental nature of charge and charged particles. Following their use of balloons to test these theories, students then are given an opportunity to construct a circuit which builds upon their knowledge of the electron as the fundamental unit of charge in electricity. Students are taught that electrons can be transported in wires and “forced” to go places and do work in the process.

Materials

5 circuit boards (includes batteries and light bulbs)

15 wires
10 balloons
5 soda cans

Module #13 – Wind Energy

General Description

The presentation discusses the topic of engineering: What do engineers do? What is energy? Where does the energy we use come from? What is renewable energy vs. non renewable energy? What is "green energy"? What is wind energy? How can wind energy be captured? What can one do once the energy is captured?

Wind energy has been used by civilization for quite some time and is one of the most simple ways to capture energy. Students are shown pictures of old windmills and can learn about how wind energy can be transformed into useful work. A relatable example of how kinetic energy can become electrical energy are flashlights that can be cranked up by hand.

Activities

Presentation:

The presentation discusses the topic of engineering and the topic of how to capture energy in particular. Aside from the important questions of wind energy in particular, the important topic of "clean" energy is introduced and students learn about using renewable energy.

Project:

Students are taught how to make a windmill to capture energy of a fan. Students learn that through capturing wind energy, they can transform that energy directly into useful work or into electricity that can later be used for other purposes.

Materials

Construction paper
Pencils with rubber erasers
Thumbtacks
Scissors
Flashlight that is hand-powered
(Fan)
(Markers or crayons)

Resources

Helpful link about renewable vs. non-renewable energy:
http://www.conserve-energy-future.com/
Helpful video about how wind turbines work:
http://www.youtube.com/watch?v=sLXZkn2W-lk

Module #14 – Sound

General Description

What is sound? How do we hear? Why are some sounds loud and others quiet? Why are some sounds deep and others high pitched? We taught the physics behind sound waves, namely that they are transverse waves made of compressions and rarefactions in the air; the equation relating the velocity, frequency, and wavelength of a wave ($v=wf$); and a short summary of how humans experience sound through our eardrums.

Activities

Presentation:
Explain that sound is made of waves of pressure change traveling through the air. Waves are like ripples in a pond. To remember sound is pressure pushing through the air, pop a balloon (pressure, push and pop all begin with the letter P). Mention speed of sound is 761 mph, which is way slower than the speed of light. This explains why we hear thunder after we see lightning, and if they happen at the same time it means the lightning was very close. Show difference between longitudinal waves and transverse waves using a two people shaking a rope up and down and "pushing" a slinky in between your two hands.

Project:
Construct instruments out of everyday objects. Some ideas for instruments are:
Comb kazoos out of combs and wax paper
Drums out of cups and balloons (chopsticks=drumsticks) (cut the stem off the balloon and place it tautly over the mouth of the cup as a drum head)
Walkie-talkies out of sets of cups and string (work better if the string is taut)
Hanger guitars out of wire hangers and rubber bands

Materials

Wire Hangers; Rubber Bands; String; Combs; Wax Paper; Cups; Balloons, Slinky

Module #15 – Health

General Description

The purpose of this module is to teach the students the importance of maintaining good health through the repeat performance of everyday healthy activities. These activities include exercise, proper nutrition, and brushing teeth for proper oral hygiene and to prevent tooth decay. Maintaining one's health through these measures will prevent a trip to the doctor later for an illness that could have been prevented by following a healthy lifestyle.

Activities

Presentation:
The importance of health as described above is presented.

Project:
We had seven different stations around the room, and divided the grade into seven groups. Each group spent about 5 minutes at each station, and then rotated to the other ones. The stations were as follows:
1. Running – the students were given pedometers to measure how many steps they can do in one minute. They took their pulse after the event.
2. Tooth Decay – we taught the students about tooth decay, by showing how a tum dissolves more in vinegar than in water
3. Jumping Jacks – we had the students perform fast jumping jacks and slow jumping jacks, and they took their pulse before and after the event
4. Relay Race – we had a relay race in which the students built a paper skeleton puzzle
5. Stretching – the students did "Simon says" to learn about stretching
6. Healthy eating habits – the students demonstrated that clogged arteries let liquid pass at a slower rate, by using playdoughto close up a tube
7. Healthy foods – a competition as to which foods contain which nutritional values

Materials

Pedometers, Vinegar, Baking Soda, Tums, Paper skeletons, Playdough, paper-tubes, water, food coloring, paper, pencils, charts for recording pulse